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ORIGINAL ARTICLE

Comparison of Phenylephrine and Ephedrine in Treatment of Spinal Induced Hypotension in Emergency Cesarean Section

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ABSTRACT

Background: *Spinal-induced hypotension is a common complication during emergency cesarean section, affecting up to 70% of parturients and potentially impacting maternal and fetal outcomes. Phenylephrine and ephedrine are widely used vasopressors to manage hypotension, yet their comparative efficacy and safety remain under investigation.* ***Objective:*** *This study aimed to compare the efficacy and safety of phenylephrine versus ephedrine in managing spinal-induced hypotension during emergency cesarean sections.* ***Methods & Materials:*** *This observational comparative study was conducted at the Department of Anaesthesia and ICU, Kurmitula General Hospital (KGH), Dhaka, Bangladesh, from January-2025 to June 2025. A total of 60 patients aged 18–40 years who underwent emergency cesarean section under spinal anesthesia were enrolled in this study and the enrolled patients were divided equally into two groups with 30 patients in each. Group-1 received intravenous phenylephrine (initial dose 100 mcg, titrated as needed), and Group-2 received intravenous ephedrine (initial dose 5 mg, titrated as needed). Maternal hemodynamics, neonatal Apgar scores, and adverse effects were recorded. Hypotension was defined as systolic blood pressure (SBP) <90 mmHg or ≥20% decrease from baseline. Data were analyzed using Statistical Package for Social Sciences (SPSS) version-23.0.* ***Results:*** *A total of 60 parturients undergoing emergency cesarean section under spinal anesthesia were included, with 30 patients in each group. The mean age was 27.8 ± 4.2 years in the phenylephrine group and 28.1 ± 4.6 years in the ephedrine group (p=0.78). Mean height (155.6 ± 5.4 vs. 156.3 ± 5.1 cm; p=0.62) and weight (63.8 ± 7.5 vs. 64.9 ± 7.1 kg; p=0.54) were similar. ASA physical status was comparable, with ASA I comprising 12 (40%) vs. 11 (36.7%) and ASA II 18 (60%) vs. 19 (63.3%) in the phenylephrine and ephedrine groups, respectively. Indications for cesarean delivery were evenly distributed between the groups: failure to progress in 9 (30%) vs. 10 (33.3%), cephalopelvic disproportion in 8 (26.7%) vs. 7 (23.3%), previous cesarean in 7 (23.3%) vs. 6 (20%), and other indications in 6 (20%) vs. 7 (23.3%) in the phenylephrine and ephedrine groups, respectively.. Phenylephrine provided significantly higher systolic blood pressure at all measured time points (5 min: 112.4 ± 8.6 vs. 105.2 ± 9.3 mmHg); (p=0.003) and lower maternal heart rates (10 min: 82.7 ± 7.6 vs. 94.3 ± 9.1 bpm;(p<0.001) compared with ephedrine. Neonatal outcomes, including one- and five-minute Apgar scores, were similar between the groups (p>0.05). Adverse effects were infrequent; bradycardia occurred more often in the phenylephrine group (16.7% vs. 3.3%, (p=0.09), while nausea and vomiting were slightly more common in the ephedrine group without statistical significance (P>0.05).* ***Conclusion:*** *Phenylephrine provides superior systolic blood pressure stability and lower maternal heart rates compared with ephedrine during spinal-induced hypotension in emergency cesarean sections, with similar neonatal outcomes and overall safety. These findings support phenylephrine as the preferred vasopressor in obstetric anesthesia for managing spinal-induced hypotension.*

Keywords: *Spinal anesthesia, hypotension, cesarean section, phenylephrine, ephedrine, maternal hemodynamics, neonatal outcomes*

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INTRODUCTION

The choice of vasopressor for managing spinal induced hypotension during emergency cesarean sections is a critical decision that can significantly impact maternal and fetal outcomes. The incidence of hypotension during spinal anesthesia for cesarean delivery can be as high as 70% [1]. Despite the widespread use of spinal anesthesia in this context, the optimal vasopressor for managing hypotension remains a topic of ongoing debate. This study aims to compare the efficacy and safety of phenylephrine and ephedrine in managing spinal-induced hypotension during emergency cesarean sections [2]. Phenylephrine and ephedrine are the two most commonly used vasopressors for this purpose. Phenylephrine is an α1-adrenergic agonist that primarily

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increases systemic vascular resistance, thereby elevating blood pressure without significantly impacting heart rate [3]. In contrast, ephedrine is a non-selective adrenergic agonist that acts on both α and β receptors, resulting in vasoconstriction along with an increase in heart rate [4]. While both agents have been shown to be effective in managing hypotension, their differential effects on maternal and fetal outcomes are not well understood [5]. Several studies have explored the efficacy of these vasopressors. For instance, a systematic review indicated that phenylephrine is associated with fewer fetal acidosis episodes compared to ephedrine [6]. Additionally, Wang et al. found that phenylephrine use resulted in more stable hemodynamics during cesarean delivery compared to ephedrine [7]. However, concerns regarding maternal bradycardia with phenylephrine have also been documented [8]. The primary objective of this study is to compare the incidence rates of hypotension and fetal acidosis between phenylephrine and ephedrine in managing spinal-induced hypotension during emergency cesarean sections. The secondary objective is to evaluate the effects of these vasopressors on maternal cardiovascular stability and neonatal outcomes [9]. Maternal cardiovascular stability is crucial, as significant fluctuations can lead to adverse outcomes for both mother and child [10]. This study will provide vital insights into optimal management strategies for spinal-induced hypotension during emergency cesarean sections. The findings will contribute to the evolving discourse surrounding anesthetic care for parturients, with the potential to enhance clinical protocols and improve patient outcomes.

METHODS & MATERIALS

This was an observational comparative study conducted at the department of Anaesthesia and ICU in Kurmitula General Hospital, Dhaka, Bangladesh during January, 2025 to June, 2025. Written informed consent was onbtained from the caregiver or legal guardian and a total of 60 emergency caesarean cases aged between 18-40 years who underwent emergency caesarean section under spinal anaesthesia were employed in this study. The study patients were divided into two groups with 30 patients in each group. Group-1 received Phenylephrine (initial dose of 100 mcg intravenously, titrating as needed) and Group-2 received Ephedrine (initial dose of 5 mg intravenously, titrating as needed). The doses were inducted following the standard protocol of spinal Anaesthesia. Before the induction of the doses, medical history and prenatal care records were reviewed and physical examination was done. Then, hemodynamic parameters (blood pressure, heart rate, oxygen saturation) were monitored. Hypotension was defined as a decrease in systolic blood pressure (SBP) ≥ 20% from baseline or SBP < 90 mmHg. Administering the assigned vasopressor was ensured if hypotension occurs. The data were collected using a pre-structured questionnaire and a case record form. The collected data were analyzed using Statistical Package for Social Sciences (SPSS), version-23.0. Descriptive statistical analysis was performed and the results were presented in tables, graphs and charts. Chi-square test and t test were performed to compare the variables between the study groups where $p<0.05$ considered as the level of significance. All ethical considerations were maintained throughout the study under the declaration of Helsinki-1964.

Inclusion Criteria:

1. Pregnant women aged 18-40 years.
2. Women underwent emergency cesarean section under spinal anesthesia.
3. ASA (American Society of Anesthesiologists) Class I and II

Exclusion Criteria:

1. History of significant cardiovascular disease.
2. Contraindications to spinal anesthesia.
3. Known allergies to phenylephrine or ephedrine.
4. Patients on medications affecting blood pressure.
5. Pregnancy induced hypertension (PIH)

RESULTS

A total of 60 pregnant women undergoing emergency cesarean section under spinal anesthesia were included in this study, with 30 cases in each group. The mean age of the patients in Group-1 (Phenylephrine) was 27.8 ± 4.2 years, while in Group-2(Ephedrine) was 28.1 ± 4.6 years (p=0.78). There were no significant differences in mean height (155.6 ± 5.4 vs. 156.3 ± 5.1 cm; (p=0.62) and weight (63.8 ± 7.5 vs. 64.9 ± 7.1 kg; (p=0.54). ASA physical status was comparable, with ASA I represented by 12 (40%) vs. 11 (36.7%) and ASA II by 18 (60%) vs. 19 (63.3%) in the phenylephrine and ephedrine groups, respectively (p=0.79) (0.088). The indications for cesarean delivery were also evenly distributed between the groups: failure to progress occurred in 9 (30%) vs. 10 (33.3%), cephalopelvic disproportion in 8 (26.7%) vs. 7 (23.3%), previous cesarean section in 7 (23.3%) vs. 6 (20%), and other indications in 6 (20%) vs. 7 (23.3%) in the phenylephrine and ephedrine groups, respectively (Table-1). Neonatal outcomes were comparable between the study groups. The mean Apgar scores at one minute (7.9 ± 0.6 vs. 7.6 ± 0.7(p=0.08) and at five minutes (8.9 ± 0.3 vs. 8.7 ± 0.4(p=0.06) showed no significant differences, indicating similar neonatal wellbeing following either vasopressor. A notable difference was observed in the hemodynamic response following vasopressor administration (Table-2) Mean systolic blood pressure (SBP) was significantly higher in the Phenylephrine group at all-time points after 5 minutes. At 5 minutes, the mean SBP in Group-1 was 112.4 ± 8.6 mmHg compared with 105.2 ± 9.3 mmHg in Group-2 (p=0.003). This trend continued at 10, 15, 25, and 30 minutes, with Group-1 consistently demonstrating better blood pressure stability ($p<0.05$) (Table-3). Phenylephrine, a pure α-agonist, resulted in lower mean heart rates at all post-induction time points compared with Ephedrine, a mixed α/β-agonist. At 10 minutes, the mean HR was significantly lower in Group-1 (82.7 ± 7.6 bpm) than in Group-2 (94.3 ± 9.1 bpm) ($p<0.001$). This significant difference persisted from 5 minutes through 30 minutes ($p<0.002$) (Table-4). Adverse effects were infrequent in both groups. Nausea and vomiting occurred more frequently in Group-2 (23.3% and 20%) compared with Group-1 (10% and 6.7%), though the differences were not statistically significant (p=0.16) and (p=0.13). Bradycardia was more common in the Phenylephrine group (16.7% vs. 3.3%; (p=0.09), consistent with its pharmacological profile. Hallucination and nystagmus were rare and observed only in one patient in the Ephedrine group. Overall, the findings suggest that Phenylephrine provided more stable systolic blood pressure and lower heart rate following spinal-induced hypotension during emergency cesarean section, with comparable neonatal outcomes and a similar safety profile when compared with Ephedrine.

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Table – I: Demographic and clinical characteristics of the study patients (*n*=60)

Variables	Group-1 (Phenylephrine) (n=30	Group-2 (Ephedrine) (n=30	P-value
Age (years), mean ± SD	27.8 ± 4.2	28.1 ± 4.6	0.780
Height (cm), mean ± SD	155.6 ± 5.4	156.3 ± 5.1	0.621
Weight (kg), mean ± SD	63.8 ± 7.5	64.9 ± 7.1	0.543
ASA Physical Status:			
I	12 (40%)	11 (36.7%)	0.791
II	18 (60%)	19 (63.3%)	0.880
Indication of cesarean delivery:			
FTP	9 (30%)	10 (33.3%)	
CPD	8 (26.7%)	7 (23.3%)	
Previous cesarean	7 (23.3%)	6 (20%)	
Others	6 (20%)	7 (23.3%)	

Table – II: Comparison of intravenous bolus doses of vasopressors required to treat hypotension and Apgar score (*n*=60)

Variables	Group-1 (Phenylephrine)(n=30)	Group-2 (Ephedrine)(n=30)	P-value
First dose required (n, %)	22 (73.3%)	27 (90%)	0.091
Second dose required (n, %)	6 (20%)	12 (40%)	0.124
Mean Apgar Score			
At 1 minute	7.9 ± 0.6	7.6 ± 0.7	0.081
At 5 minutes	8.9 ± 0.3	8.7 ± 0.4	0.062

Table – III: Comparison of mean systolic BP between the study groups with respect of time (*n*=60)

Time	Group-1 (Phenylephrine) Mean ± SD	Group-2 (Ephedrine) Mean ± SD	P-value
0 minutes (baseline)	69.1 ± 1.8	68.2 ± 1.2	0.741
5 minutes	112.4 ± 8.6	105.2 ± 9.3	0.003
10 minutes	110.6 ± 7.9	103.8 ± 8.5	0.001
15 minutes	113.1 ± 6.8	106.9 ± 7.2	0.002
25 minutes	115.3 ± 6.9	110.1 ± 7.4	0.01
30 minutes	116.1 ± 7.0	111.4 ± 7.6	0.02

Table – IV: Comparison of mean heart rate between the study groups with respect of time (*n*=60)

Time	Group-1 Phenylephrine) Mean ± SD	Group-2 (Ephedrine)Mean ± SD	P-value
0 minutes (baseline)	89.2 ± 8.4	88.5 ± 8.1	0.771
5 minutes	84.1 ± 7.9	92.8 ± 8.4	<0.001
10 minutes	82.7 ± 7.6	94.3 ± 9.1	<0.001
15 minutes	83.3 ± 7.2	95.1 ± 8.7	<0.001
20 minutes	84.2 ± 6.9	93.7 ± 8.2	<0.001
25 minutes	85.4 ± 7.1	92.6 ± 7.9	0.001
30 minutes	86.3 ± 7.0	91.4 ± 8.1	0.002

Table – V: Comparison of adverse effects and complications between the study groups (*n*=60)

Adverse Effects	Group-1 (Phenylephrine) (n=30)	Group-2 (Ephedrine) (n=30)	P-value
Nausea (n, %)	3 (10%)	7 (23.3%)	0.161
Vomiting (n, %)	2 (6.7%)	6 (20%)	0.132
Bradycardia (n, %)	5 (16.7%)	1 (3.3%)	0.09
Hallucination (n, %)	0	1 (3.3%)	0.312
Nystagmus (n, %)	0	1 (3.3%)	0.314

DISCUSSION

This study compared phenylephrine and ephedrine for the management of spinal anesthesia–induced hypotension during emergency cesarean section in 60 patients, with 30 in each group. Baseline characteristics such as age (27.8 ± 4.2 vs. 28.1 ± 4.6 years), height (155.6 ± 5.4 vs. 156.3 ± 5.1 cm), and weight (63.8 ± 7.5 vs. 64.9 ± 7.1 kg) were similar between the phenylephrine and ephedrine groups, indicating proper randomization and comparability. A key finding of this study was the significantly higher systolic blood pressure in the phenylephrine group at all measured time points. At 5 minutes after spinal anesthesia, mean SBP was 112.4 ± 8.6 mmHg in the phenylephrine group compared with 105.2 ± 9.3 mmHg in the ephedrine group ($p = 0.003$). This trend continued consistently at 10, 15, 20, 25, and 30 minutes ($p < 0.05$). These results reinforce the well-established α-adrenergic vasoconstrictive effect of phenylephrine, which has been shown to provide superior blood pressure maintenance compared with ephedrine in cesarean deliveries[11,12]. Another important finding was the significantly lower maternal heart rate in the phenylephrine group across all post-induction intervals. For example, at 10 minutes, the mean HR was 82.7 ± 7.6 bpm in the phenylephrine group versus 94.3 ± 9.1 bpm in the ephedrine group ($p < 0.001$). This phenomenon is consistent with reflex bradycardia due to increased systemic vascular resistance caused by phenylephrine [13]. The persistently higher heart rates in the ephedrine group align with its mixed α/β-agonist activity and its tendency to increase cardiac output. Neonatal outcomes were also comparable between the two groups. The mean Apgar score at

one minute was 7.9 ± 0.6 in the phenylephrine group and 7.6 ± 0.7 in the ephedrine group (p = 0.08). At five minutes, Apgar scores were 8.9 ± 0.3 vs. 8.7 ± 0.4 (p = 0.06). Although phenylephrine induces more maternal bradycardia, it is associated with less placental transfer than ephedrine, which may explain the absence of significant differences in neonatal well-being. Prior studies have demonstrated that ephedrine is linked with fetal acidosis due to higher fetal exposure [14, 15], whereas phenylephrine is considered safer in terms of neonatal acid–base status [16, 17]. Adverse effects in this study were infrequent and mostly mild. Nausea occurred in 10% of phenylephrine-treated patients compared with 23.3% in the ephedrine group, while vomiting occurred in 6.7% vs. 20%, respectively, though neither reached statistical significance. These findings are consistent with previous reports associating ephedrine-induced tachycardia and sympathetic stimulation with increased maternal nausea and vomiting [18]. Bradycardia was more common in the phenylephrine group (16.7% vs. 3.3%), matching the expected pharmacological effects of pure α-agonists [19]. Hallucination and nystagmus were rare and noted only in one ephedrine-treated patient, consistent with isolated reports describing ephedrine-related CNS stimulation [20].Overall, the major findings of this study significantly better systolic blood pressure stability, significantly lower maternal heart rate, similar neonatal Apgar scores, and a comparable safety profile align with current international evidence favoring phenylephrine as the primary vasopressor in obstetric anesthesia. A recent randomized controlled trial support phenylephrine's superior hemodynamic control and reassuring neonatal outcomes compared with ephedrine [21]. These findings collectively strengthen the recommendation for phenylephrine as the vasopressor of choice for managing spinal-induced hypotension in both elective and emergency cesarean sections.

LIMITATIONS OF THE STUDY

This study has some limitations. It was a single center study with limited samples over a short study period, which may restrict the generalizability of the findings to broader populations of the whole country. These limitations highlight the need for future prospective, multicenter study to justify the results of this present study.

CONCLUSION

This study shows that phenylephrine provides significantly better systolic blood pressure stability and lower maternal heart rate than ephedrine during emergency cesarean section under spinal anesthesia, while neonatal Apgar scores and adverse effects remain comparable between the two groups. These findings indicate that phenylephrine is a more effective and reliable vasopressor for managing spinal-induced hypotension without compromising neonatal wellbeing, supporting its use as the preferred agent in obstetric anesthesia.

RECOMMENDATIONS OF THE STUDY

Based on the study findings, it is recommended that phenylephrine be adopted as the first-line vasopressor for managing spinal-induced hypotension during emergency cesarean sections, given its superior blood pressure stabilization and predictable maternal heart rate response without adverse effects on neonatal Apgar scores. Clinical protocols should incorporate phenylephrine as the preferred agent, while ephedrine may be reserved for selected cases based on individual hemodynamic profiles. Further multicenter studies with larger samples are suggested to validate these results and support broader guideline implementation in obstetric anesthesia practice.

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